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Failing to Yield? Ploughs, conservation agriculture and the problem of agricultural intensification. An example from the Zambezi Valley, Zimbabwe

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Failing to Yield?

Ploughs, conservation agriculture and the problem of agricultural intensification

An example from the Zambezi Valley, Zimbabwe

ABSTRACT *Agricultural intensification, or increasing yield, has been a persistent theme in policy interventions in African smallholder agriculture. This article focuses on two hegemonic policy models of such intensification: (1) the ‘Alvord model’ of plough-based, integrated crop-livestock farming promoted in colonial Zimbabwe, and; (2) minimum-tillage mulch-based, Conservation Agriculture (CA), as currently preached by a wide range of international agricultural research and development agencies. An analysis of smallholder farming practices in Zimbabwe’s Zambezi Valley, reveals the limited inherent understanding of farmer practices in these models. It shows why many smallholder farmers in southern Africa are predisposed towards extensification rather than intensification, and suggests that widespread CA adoption is unlikely.*

1. Introduction

‘The Gospel of the Plow means working together with God, in order to get good crop yields while at the same time we take good care of the soil (...) In order to bring this about, a spirit of reverence for the soils must be created, which is... a sort of religion (...) The heathen African dug his land while standing trees, skeletons, stumps and fallen trees were scattered all about. ...he planted the seed and trusted to the witchdoctors, rainmakers, ancestral spirits and demons to do the rest. (...) if those people could only be taught the Gospel of the Plow...’ (Emery Alvord, *Agriculturalist for Natives in Southern Rhodesia from 1926 to 1950*)¹

‘Conservation Agriculture [CA]... can be difficult for many people to accept because it goes against many of their cherished beliefs. How can crops be grown without plowing the land? Overcoming this

1
2
3 mindset of the need for plowing is a major step in achieving successful CA systems.' (*Zimbabwe CA*
4
5 *Taskforce, 2008:5*)²
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9 'God has revealed a very simple conservation farming method with an implementation management
10
11 teaching, which when applied, helps people to apply the Gospel to their lives.' (*Foundations for Farming,*
12
13 *formerly Farming God's Way website, 2010*)³
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18 The above quotes signal two persistent themes in the history of agricultural intervention in the
19
20 smallholder sector in southern Africa. First, the perception that smallholder farmers' practices
21
22 are backward, destructive, and in need of revelation. Second, the religious zeal by which
23
24 (colonial) interventionists have sought to persuade African farmers to adopt more intensive
25
26 agricultural practices, that is, to increase yield (harvest per surface area). This is most evident
27
28 in Zimbabwe where an agricultural intensification package was promoted as early as the
29
30 1920s. Emery Alvord, an American missionary, turned the plough into a symbol of modern
31
32 agriculture while promoting a package of integrated crop-livestock farming. It became the
33
34 hegemonic model for African farming underpinning a wide range of policy interventions in
35
36 African agriculture in colonial Zimbabwe (Wolmer and Scoones, 2000; Bolding, 2004). Such
37
38 interventions initially took the form of 'demonstrations' to African farmers, but religious zeal
39
40 increasingly made way for compulsion.
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46
47 Contemporary attempts at agricultural intensification in African agriculture continue to be
48
49 informed by conservationist concerns. Yet, in contrast to the plough-based Alvord model,
50
51 current interventions are based on minimum-tillage and retention of a mulch of crop residues,
52
53 through a technical package referred to as 'Conservation Agriculture'⁴, CA. A powerful lobby
54
55 of international donors, development and agricultural research agencies crusades to extend
56
57 what has become the current hegemonic policy model for agricultural intensification.
58
59 Collaborating in a taskforce, NGOs and donors promoting CA have garnered considerable
60

1
2
3 financial and political support in Zimbabwe⁵. The model has even been included in the
4
5 National Agricultural Policy of Zambia (MACO, 2004), and recognised by Zimbabwe's
6
7 president as a means to 'make savings on draught power requirements and minimise land
8
9 degradation'⁶.

10
11
12 This article analyses these two hegemonic policy models for agricultural intensification
13
14 from a comparative perspective. Highlighting some striking similarities in extension
15
16 approach, notably the invocation of God and the use of science-based demonstration plots, the
17
18 main focus is on the ideas and inherent assumptions about smallholder farming systems
19
20 underpinning both models. It is suggested that protagonists of CA have learned little from the
21
22 earlier, colonial attempts to intensify smallholder agriculture as spearheaded by Alvord. While
23
24 resource conservation and sustainable production have remained persistent concerns guiding
25
26 interventions in smallholder agriculture, so remains the disregard for the socio-economic
27
28 circumstances and the rationale of African smallholder practices⁷. Like in Alvord's days,
29
30 interventions take a 'one size fits all' form that ignores the diversity of existing farming
31
32 practices. Farming Systems Research (FSR) and subsequent participatory approaches –
33
34 epitomised by the 'Farmer First' approach (Chambers et al., 1985) – appear to have had no
35
36 bearing on the development and extension of CA to smallholder farmers in Africa. Rather
37
38 than questioning the agronomic merits of the technologies promoted, this article is therefore
39
40 concerned with the *suitability* of CA technologies to the socio-economic realities of
41
42 smallholder farming systems in southern Africa.

43
44
45 Malnutrition and population growth (2.3% per annum) underline the need for increased
46
47 agricultural production in sub-Saharan Africa. As the most suitable areas for agriculture are
48
49 already cultivated, agricultural intensification seems a logical strategy (World Bank, 2008).
50
51 Yields in smallholder farming systems of southern Africa remain appallingly low despite
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53 technological innovations such as improved seeds and fertilisers. Average cereal yields in
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3 smallholder agriculture have stagnated in Africa since the 1960s, whilst they have nearly
4 doubled in the rest of the world (Huang et al., 2002). Large-scale commercial farming on the
5 African continent also performs considerably better than the smallholder sector. For instance,
6 in Zimbabwe in the period 1970–2000, maize yield averaged 0.8 t ha^{-1} (std. dev. 0.4 t ha^{-1}) for
7 the smallholder sector and 3.9 t ha^{-1} (std. dev. 1.0 t ha^{-1}) for the commercial farming sector
8 (Andersson, 2007). Differences in agricultural potential go a long way in explaining this
9 disparity, as the best agricultural lands were expropriated for white settlers during the colonial
10 era. However, even in similar agro-ecological circumstances, huge differences in yields are
11 observed between the majority of smallholder farmers and the best performing ones (Zingore
12 et al., 2007), suggesting that while a potential for higher land productivity exists, it is not
13 realised because of social and economic factors (Djurfeldt et al., 2008). By inferring from an
14 analysis of the labour, cash and price constraints, as well as risk mitigation strategies of
15 smallholder farmers in northern Zimbabwe, it is shown why many smallholder farmers in
16 southern Africa do not – or are not able to – intensify their production, but instead, are
17 disposed towards agricultural extensification. Appreciating the rationale of existing farming
18 practices of smallholder farmers, it is suggested that many farm practices promoted under the
19 banner of CA are likely to befall a similar fate as Alvord’s recommendations for agricultural
20 intensification.

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48 This article is divided in two parts. Part I compares the Alvord model and CA, looking at the
49 ideas and assumptions underpinning the technologies promoted, the extension approaches
50 deployed, and the fate of the Alvord model some 80 years after it was introduced. Part II
51 shifts the attention to smallholder farming practices and their embedding in a wider socio-
52 economic environment. It builds on extensive fieldwork in Dande Communal Area in the
53 Zambezi Valley, a sparsely-populated agricultural frontier in northern Zimbabwe,
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1
2
3 characterised by increased competition over land between nature conservation and agriculture
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5 (Baudron et al., 2011). As elsewhere in southern Africa, the extension of CA in this area is
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7 seen as a way to enable a sustainable increase in yields with minimum negative consequences
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9 for the environment.
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11

12 13 14 15 **PART I: MODELS OF AGRICULTURAL INTENSIFICATION** 16

17 18 **2. Theoretical models of agricultural production growth** 19

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22
23 Two ideal-typical models to increase agricultural production may be distinguished. First,
24
25 increased farm output may be achieved through 'extensification'; extending the area under
26
27 cultivation, while maintaining or reducing inputs per unit area (Figure 1a). Yields remain
28
29 stable or decrease whilst water and nutrient losses per unit area often remain unaltered
30
31 (Erenstein, 2006). Second, production increases may be achieved by means of intensification.
32
33 Yield is increased through greater capital and/or labour input per unit area. The 'Green
34
35 Revolution', which drove massive production increases in Asia (World Bank, 2008), is a
36
37 typical example of capital-driven intensification (that is use of hybrid seeds, chemical inputs
38
39 and mechanization; Figure 1b). 'Ecological intensification' increases resource use efficiency -
40
41 for example light, water and nutrient use (Figure 1c; Giller et al., 2002; 2006). It revolves
42
43 around the idea of sustainable production, seeking to increase land productivity while
44
45 conserving natural resources, that is soil, water, and surrounding wild nature. However,
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47 ecological intensification often requires more labour per unit area.
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Figure 1

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3 Farming technologies are often classified as either land-saving or labour-saving, that is, as
4 resulting in agricultural intensification and extensification respectively (Erenstein, 2006). In
5 practice, however, technologies may be used differently, rendering a clear-cut classification
6 problematic. Intensification and extensification are seldom mutually exclusive. For instance,
7 whereas chemical fertilisers are generally seen as a land-saving technology, their massive
8 adoption by Zimbabwean smallholder maize growers in the mid 1980s went hand in hand
9 with an expansion of land cropped with maize (Andersson, 2007).

10
11 Besides farming technologies, socio-economic circumstances may also direct farm
12 development toward intensification or extensification. First, whilst agricultural intensification
13 is often triggered by land scarcity, extensification is a common strategy when sufficient land
14 is available (Boserup, 1965; Erenstein, 2006). Second, proximity to urban markets increases
15 the incentives for intensification, reducing costs for input procurement and marketing
16 (Woodhouse, 2002; Erenstein, 2006). Similarly, unfavourable market access in remote areas
17 may hamper intensification (Woodhouse, 2002; Bamire and Manyong, 2003).

18
19 Below we discuss the Alvord and CA models for the intensification of African
20 smallholder agriculture. Although developed in different historical contexts and based on
21 different technologies – most notably, opposing views regarding use of the plough – the
22 paragraphs below reveal a striking historical continuity in their disregard for the rationale of
23 existing farm practices, and in their extension approach.

24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 **3. Segregation, modernization and erosion control: the ‘Alvord model’ of agricultural** 53 **intensification**

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58 Emery Alvord’s appointment as “Agriculturalist for the Instruction of Natives” in 1926 was
59 the result of a proposal for the industrial development of Africans, formulated by the Chief
60

1
2
3 Native Commissioner, Mr. Keigwin (Bolding, 2003:37). Agricultural intensification in the
4
5 lands set aside for African occupation – the Native Reserves (now called Communal Areas) –
6
7 was Alvord's key task. He was to,
8
9

10
11 ... develop Native Reserves so as to enable them to carry a larger population, and so avoid, as far as
12
13 possible, the necessity for acquisition of more land for native occupation.' (Chief Native Commissioner,
14
15 Annual Report 1932)
16
17

18
19 Alvord's efforts were thus part and parcel of the colonial governments' racial segregation
20
21 policies. Concentrating more people in the Native Reserves meant that permanent cultivation
22
23 had to replace the common practice of shifting cultivation. While working as a missionary at
24
25 Mount Selinda on the country's eastern border, Alvord developed a set of agricultural
26
27 practices that could increase yields and modernise African agriculture (Page and Page, 1991;
28
29 Davis, 1992). Laid down as 'commandments' for permanent agriculture (Bolding, 2004: 53),
30
31 the 'Alvord model' of modern agriculture became an integral part of the civilizing enterprise
32
33 colonial officials and missionaries such as Keigwin and Alvord had set themselves.
34
35 Emblematically represented by the plough, a set of blanket recommendations consisting of
36
37 five key practices – ploughing, manuring, crop rotation, sole cropping⁸ and planting in lines –
38
39 sought to sustain the permanent cultivation of the generally poor soils of the Native Reserves
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44 (Table 1a, Page and Page, 1991; Davis, 1992). In agronomic terms, this farming model aimed
45
46 to increase both input supply to the crop (for example manure application) and resource use
47
48 efficiency through improved crop management (for example planting in lines).
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Table 1

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3 *From 'demonstration' to compulsion*
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8 Underpinned by an ideology of racial segregation and paternalistic development, Alvord's
9 package for 'modern agriculture' was promoted in a number of ways. At agricultural training
10 centres in Domboshawa, north of Harare, and in Tsholotsho, in the south, mission-educated
11 Africans were trained to become 'agricultural demonstrators' (extension workers). They were
12 placed in the Native Reserves to demonstrate the standardised set of modern husbandry
13 practices in the fields of those willing to adopt 'modern agriculture'. Alvord emphasised that
14 demonstrators were to work the plots together with the plot owners, building on 'learning by
15 doing' and 'seeing is believing' (Bolding, 2003: 44, 46). A second policy was the Master
16 Farmer programme, a training programme for farmers that has survived well into the post-
17 colonial era (see Bolding, 2004).
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32 As Alvord rolled out his demonstration and Master Farmer programmes, land degradation
33 in the Native Reserves seemed only to worsen in the eyes of colonial government officials,
34 including Alvord himself. Fuelled by a visit to the USA during the Great Dust Bowl in 1935,
35 colonial interventions in African smallholder agriculture became increasingly informed by
36 conservationist concerns (McGregor, 1995; Wolmer and Scoones, 2000). Although blamed on
37 African smallholders' misuse of the land, land degradation in the Reserves was partly of the
38 colonial governments' own making. More and more people were pushed onto these
39 degradation-prone lands (Andersson, 2007: 683). In addition, the alarming rates of soil
40 erosion were often based on landscape-level aggregations of plot-level estimates, thus
41 ignoring the complex patterns of deposition across landscapes (Campbell et al., 1997)⁹.
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55 However ill-informed, erosion rates were used to justify more stringent soil conservation
56 policies such as the Natural Resources Act of 1941, which empowered Native Commissioners
57 to issue orders on – 'Alvordian' – farming methods to be used, and compel African farmers to
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1
2
3 construct soil conservation works such as contour ridges (Phimister, 1986; Machingaidze,
4
5 1991). Alvord's mixed farming model which integrated crop and livestock production was
6
7 also the basis of the Native Land Husbandry Act of 1951, which sought to enforce agricultural
8
9 intensification by individualizing and limiting African farmers' land and livestock holdings
10
11 (Machingaidze, 1991; Phimister 1993; Andersson 1999).
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20 *Alvord's gospel, technology adoption and the plough*
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22
23 Demonstrated and enforced, Alvord's standardised model for 'modern farming' has left its
24
25 legacy. Zimbabwean smallholders have adopted and adapted some or all five key practices –
26
27 ploughing, manuring, crop rotation, sole cropping and planting in lines – despite criticism on
28
29 their agronomic merits, applicability, and sustainability (for an overview, see Bolding, 2003).
30
31 For instance, already during his time in office (1926-1950), Alvord had to acknowledge that
32
33 his manure recommendations to maintain soil fertility in permanently cultivated lands were
34
35 ill-suited. Most smallholder farmers simply did not have enough cattle (12-16 head per arable
36
37 hectare) needed to supply the required rate of manure (Bolding, 2003: 51).¹⁰ In 1965, it was
38
39 estimated that less than half of the Native Reserve farmers owned any cattle at all
40
41 (Machingaidze, 1991). Alvord's crop rotations were equally unsuited to the conditions of
42
43 smallholder farmers as they did not take into account the different labour requirements,
44
45 dietary needs and preferences or marketability of different crops (see below). Ploughing, sole-
46
47 cropping and planting in lines have, however, become widely practised and regarded as
48
49 proper farming practice by smallholder farmers. But did these 'Alvordian' technologies result
50
51 in agricultural intensification? These three components of the package do have land-saving
52
53 properties – that is that may lead to intensification – but they also have labour-saving
54
55 properties – that is that may lead to extensification (Table 1a). In many areas where
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3 population was sparse, they enabled farmers to manage larger lands, and if close to markets,
4
5 this gave rise to a category of so called 'plough entrepreneurs', who opened up extensive land
6
7 areas to increase production (Ranger 1985: 36; Phimister 1988: 72-79,143). Colonial
8
9 administrators noted:
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16 '...the native is rapidly taking to the plough and the use of the plough is becoming almost general
17
18 throughout the country... the average yield in bags per acre is deplorably low and has decreased with the
19
20 advent of the plough.'¹¹
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25 In those areas where population had become dense - as a result of the colonial state's
26
27 segregationist land policies - such an extensification-based development path was less
28
29 feasible. It was in these areas that Alvord's demonstrators 'tended to secure the greatest
30
31 degree of cooperation from cultivators' (Phimister 1988: 275), adopting labour demanding
32
33 components such as manuring. But even in these densely populated areas, demonstrators were
34
35 generally welcomed by only a few farmers, most notably the entrepreneurial ones, as they
36
37 reduced their labour burden. In some cases demonstrators even assumed the role of farm
38
39 managers for entrepreneurial farmers (Ranger 1985:62; Phimister 1988:143-145). The
40
41 adoption of the plough for agricultural extensification thus has to be understood in the context
42
43 of smallholder's production constraints and market opportunities. Both were at least partially
44
45 structured by colonial land and marketing policies.
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50
51 It is perhaps somewhat ironic that in his autobiography, 'The Gospel of the Plow', Alvord
52
53 took the plough as the symbol of his life-time efforts to intensify African land use. In 1926,
54
55 when Alvord was appointed, it was estimated there were already over 27,000 ploughs in use
56
57 in the Native Reserves. In the following five years this number almost doubled to over
58
59 53,000, when a mere 37 demonstrators were working in the Native Reserves (Government of
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1
2
3 Southern Rhodesia, 1952). Alvord and his demonstrators were thus not responsible for the
4
5 rapid uptake of the plough by African farmers. Alvord referred to the rise of the plough as a
6
7 mixed blessing, lamenting its 'misguided' use; extensive ploughing could increase soil
8
9 erosion and farmers who opened up large tracks of land with the plough, could often not
10
11 manage the additional hand-weeding (Bolding, 2003: 55-56). Nevertheless, the success of
12
13 African smallholders' extensive market production of maize brought them in direct
14
15 competition with white settler farmers. The latter turned against colonial officials like Alvord
16
17 for stimulating Africans to produce. The settler state yielded to pressures of the white farmers,
18
19 and introduced discriminatory marketing legislation such as the Maize Control Act (1931),
20
21 which reduced market prices for African producers. Such state intervention in markets did not
22
23 always cause reduced market production: 'The percentage of African sales to total African
24
25 production and to total sales increased significantly' in the 1930s, as farmers tried to sustain
26
27 their income by producing more (Phimister 1988:186). State-induced falling market prices
28
29 could thus contribute to agricultural extensification as farmers tried to reduce costs. For
30
31 Alvord, however, it was the lack of grain markets for African producers that was to blame for
32
33 the failure of intensification (Stocking, 1978; Page and Page, 1991; Davis, 1992).

34
35 Rather than Alvord's recommendations and extension programmes, the growing
36
37 population concentrated in the Native Reserves that eventually forced smallholder farmers to
38
39 cultivate the same land permanently. Alvord's recommendation to use manure followed as an
40
41 – insufficient – response to declining yields, as did the use of mineral fertilisers. Having had
42
43 no regard for the production constraints of smallholder farming systems, it can be concluded
44
45 that in his time (1926-1950), Alvord's package for agricultural intensification was largely a
46
47 failure, as it was diverted for extensification. Yet the legacy of his 'Gospel of the Plough' is
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49 immense, as the next sections will reveal.
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4. From plough adoption to abandonment: what has changed?

Stemming land degradation through Conservation Agriculture

Conservationist concerns continue to inform agricultural intervention in the post-colonial period. Now framed in terms of an eroding natural resource base and biodiversity loss, underpinning contemporary policies is the persistent idea that African farming practices are both unproductive and destructive. Not surprisingly, Zimbabwe has been fertile ground for the introduction of Conservation Agriculture (CA). Based on the simultaneous application of three principles – minimal soil disturbance, permanent soil cover, and crop rotations (www.fao.org/ag/ca; Table 1b) – this model of ecological intensification (Figure 1c) has recently gained momentum in southern Africa following its successful adoption on large-scale mechanised farms in South America, North America and Australia (Kassam et al., 2009). In the latter, CA depended on use of labour-saving herbicides (unlike the hand-hoe basin-based packages promoted to Zimbabwean smallholders). It may be seen as a new gospel, this time to abandon the plough (see wwwFOUNDATIONSFORFARMING.org).

The CA principles of minimum soil disturbance, achieved through minimum-tillage, and permanent soil cover through retention of a mulch of crop residues are interdependent practices (as tillage would bury the mulch). Other components of the technological package can be viewed as consequences (Figure 2). For example, crop rotation becomes necessary as crop residues retained on the soil as mulch may carry pests and diseases.

Recent projects and training manuals promoting CA evidence a tendency to include more and more technological components. For instance, the Foundations for Farming¹² promotes composting as part of the CA package, ICRISAT includes fertiliser micro-dosing (Twomlow et al., 2008a), while ICRAF promotes ‘Conservation Agriculture with trees’¹³. Although such

1
2
3 additions evidence the popularity and strategic value of the CA concept for donor-dependent
4
5 research and development organizations, these additions are also responses to the ambiguous
6
7 impact of some CA components on land and labour productivity (Table 1b). In order to
8
9 increase the suitability of CA to smallholder farming systems, new technical components are
10
11 constantly added in an attempt to increase benefits, or to overcome the negative effects on
12
13 crop production. Adopting CA thus results in a cascade of technologies to be adopted, and
14
15 possibly, in a complete overhaul of existing practices (Figure 2). Hence, more than Alvord's
16
17 technologies which have been adopted rather independently from one another, CA is a
18
19 'technology package' – a set of interrelated components that require wholesale adoption to
20
21 result in increased production (Table 1b; Figure 2).
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30 Figure 2

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35 *Conversion justified with science... and extended with faith*
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40 The similarities between the Alvord and CA models for agricultural intensification extend
41
42 beyond a shared ideology of resource conservation and land degrading farm practices of
43
44 African smallholders. First, protagonists of CA deploy similar extension strategies. For
45
46 instance, in manuals, documentaries and slide-shows¹⁴, the land degrading and inefficient
47
48 nature of African smallholder agriculture is often illustrated by pictures of gully erosion and
49
50 farmers in fields with stunted, yellowish crops. The superiority of the particular CA package
51
52 promoted is then demonstrated scientifically, through detailed plot-based comparisons of
53
54 yields, soil erosion, and runoff rates between CA and conventional farming (see for example
55
56 Thierfelder and Wall, 2009)¹⁵. As in Alvord's days, quantifications of land degradation are
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3 used strategically to communicate urgency, and the need for revelation of ‘farmer mindsets’
4
5 (CA Taskforce, 2008: 5; Hobbs et al., 2008).
6
7

8 Invoking God and the gospel constitutes a second congruence between Alvord and CA
9
10 protagonists. Just as Alvord, who built on mission-educated demonstrators and Christianised
11
12 ‘modern’ farmers that were presumably freed of superstitious beliefs like witchcraft (Page and
13
14 Page, 1991), CA is often financed and extended through churches and faith-based
15
16 organisations¹⁶. For instance, Brian Oldreive’s River of Life Church has been at the forefront
17
18 of its promotion in Zimbabwe. Viewing CA as a way to farm ‘faithfully’, he equated it with
19
20 ‘Farming God’s Way’ (Oldreive, 2005). Soil cover with mulch is referred to as ‘God’s
21
22 blanket’. The promotion of CA thus becomes an evangelizing enterprise.
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30 *A technology-driven approach, disregarding farm practice: “one size fits all”*
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34 Arguably, the most striking similarity between Alvord’s model for agricultural intensification
35
36 and CA is the disregard for the rationale of existing farm practices and for the diversity of
37
38 socio-economic environments within which they take place. In Alvord’s days, local practices
39
40 such as shifting cultivation were perceived as wasteful and destructive, to be replaced by
41
42 ‘modern’ integrated crop-livestock farming, modelled on northern European and American
43
44 family farms (Wolmer and Scoones, 2000). Similarly, the extension of CA to smallholder
45
46 farmers in southern Africa is modelled on its success in large-scale, mechanised farms in the
47
48 Americas and Australia (Giller et al., 2009).
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53 Labelling existing farm practices as wasteful and destructive is, of course, a convenient
54
55 way to ignore them altogether and justify the blanket recommendation of a new set of
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57 practices. Although Alvord’s understanding of African agriculture was considerable (see
58
59 Alvord, 1929), he operated within the confines of the segregationist colonial state that sought
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1
2
3 to concentrate Africans in reserves, intensify agriculture there, while simultaneously
4
5 suppressing smallholder farmers' market production. Regardless Alvord's awareness of these
6
7 contradictory goals of colonial policy, his package was primarily a technological one,
8
9 ignoring the embeddedness of farming practices in a wider socio-economic environment – its
10
11 labour constrained production in particular.
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15 Protagonists of CA appear to have learned little from Alvord's experiences. Again an
16
17 intensification package is promoted as a 'one size fits all' set of technologies, without much
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19 attention for existing farming practices and the suitability of the promoted technologies within
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21 the socio-economic context in which they are to be adopted.
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25 Below, in Part II, the focus shifts to understanding smallholder farming practices within
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27 their specific socio-economic environment. Understanding such practices, it is suggested,
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29 casts doubts on the suitability of CA.
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32 33 34 **PART II: FARMER PRACTICE VS. INTENSIFICATION MODELS** 35

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38 The material presented below builds on fieldwork among smallholder farmers in Dande
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40 Communal Area in the Zambezi Valley, a relatively thinly populated area (17 pers. km⁻² in
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42 2002) in northern Zimbabwe. Here, agricultural intensification is seen as a way to spare land
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44 for wildlife conservation beyond the borders of nearby protected areas. The analysis aims to
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46 understand better the rationale of African smallholder farming, and particularly, trajectories of
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48 farm development. It is shown why Zambezi valley farmers are predisposed towards
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50 agricultural extensification.
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55 A survey ($n = 176$) was used to construct a typology of farmer diversity in the study area,
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57 based on their practices and endowment. Four farmer types were delineated: hand-hoe farmers
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59 not growing cotton (Type 1); hand-hoe farmers growing cotton (Type 2); ploughing farmers
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3 growing cotton and having less than four draught animals (Type 3); and ploughing farmers
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5 growing cotton and having four draught animals or more (Type 4)¹⁷. A sub-sample of 38
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7 farmers representative of farmer diversity was selected for a detailed analysis of decision-
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9 making processes governing resource allocation to farming. First, farm labour and cash
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11 calendars were constructed. A second round of interviews focused on farmers' perspectives
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13 on 'good farming' and his/her preferences for farm development if specific inputs were
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15 increased. To facilitate dialogue on these development pathways, a role-playing game was
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17 used: the "Dande Game". The Dande Game was made of a board representing the major soil
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19 types farmers distinguish: upland loamy sand ("*shapa*") and upland sandy clay loam
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21 ("*mutapo*"), and sandy loam near rivers ("*bandate*"). Bottle tops were used to represent one
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23 acre plots of the five major crops cultivated in the area – cotton, maize, sorghum, cowpea and
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25 groundnut. Production assets such as labour and spans of animal draught power were
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27 represented by cards. The game was played by first asking the interviewee to represent the
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29 crop-soil type combinations of his/her farm as it was during the previous cropping season.
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31 Farmers were then asked how they would change their cropping pattern under various
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33 scenarios, such as access to all major soil types, more draught animals, or increased labour
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35 availability. During the discussions, farmers were asked to reflect on specific technologies
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37 associated with CA, that is minimum-tillage, crop residue mulching, crop rotation and
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39 intercropping with legumes. Issues discussed during these interviews were also raised in
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41 group interviews in three wards along a west-east gradient of increased population density and
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43 less tsetse infestation (see Baudron et al., 2011): from Angwa Bridge to Mazambara and
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45 Mushumbi Pools. This gradient is significant for the understanding of farm diversity as tsetse
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47 infestation prevents the use of animal drawn ploughs, while higher population densities may
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49 limit farm expansion.
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5. Organizing production: smallholders' disposition towards agricultural extensification

Labour constrained production

In southern Africa, farming is often limited by labour rather than land. In Zimbabwe's Zambezi Valley, available animal draught power and manpower are good predictors of farm size (Baudron et al., 2011). Hand-hoe farmers (Types 1 and 2) on average cultivate 2.1 ha, while ploughing farmers with one (Type 3) and two animal spans (Type 4) on average cultivate 3.6 and 6.0 ha, respectively.

Southern Africa is characterised by a narrow optimum planting window (Phillips et al., 1998; Raes et al., 2004), while timely first weeding is crucial to avoid problems of crop establishment (Vogel, 1994). As labour calendars evidence, smallholder farming in the Zambezi Valley, is characterised by two labour peaks; one at land preparation and planting in November-December, and one at the first weeding in January (Figure 3). For hand-hoe farmers (Type 1 and 2), who generally lack resources to hire labour, the labour peak at first weeding is particularly pronounced. Weeds grow fast and vigorously because of the relatively fertile soils and high temperatures that characterise the Zambezi Valley. For Type 1 and 2 farmers, land preparation and planting are spread over a longer time period, as field clearing and the opening of planting stations can already commence before the onset of the rains. However, weed growth is not controlled by ploughing nor are weeding efforts alleviated by the use of ox-drawn cultivators. In contrast, ploughing farmers (Type 3 and 4) face two labour peaks. These farmers can only start land preparation and planting after the onset of the rains, as ploughing requires moisture to soften the soil. Although ploughing and the use of labour-saving cultivators controls weed growth, these farmers still face a labour peak at weeding; a cultivator does not eliminate the need for manual weeding between plants in the same row (Figure 3).

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3 In the Zambezi Valley, the labour peak at the time of first weeding is a major determinant
4 of the land area harvested, even for ploughing farmers. Farmers who cannot mobilise enough
5 labour at first weeding, are forced to abandon parts of their planted field as exemplified by
6 data from the EU-PARSEL project in the area. During the 2008-2009 season 28% of sorghum
7 fields ($n = 164$) and 17% of cotton fields ($n = 149$) decreased by almost a third in size
8 between planting and harvesting time.
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17 The primacy of the labour peak at first weeding explains Zambezi Valley farmers'
18 preference for technologies such as ploughing and residue burning that save labour at this
19 time of the season (see below). Ploughing generally reduces weed infestation at planting time
20 and is more effective in controlling perennial weeds than minimum-tillage (Vogel, 1994),
21 whilst manual weeding is easier on a bare soil than on a mulched soil (see below). In
22 opposition, technologies that increase labour demand during weeding are ill-suited to
23 smallholders of the Zambezi Valley, particularly the resource poor. From discussions with
24 farmers, this appears to be the case for minimum-tillage and mulching, the main components
25 of CA (Table 1b).
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Figure 3

Mobilizing cash for farming

51 To overcome labour constraints, farmers may purchase herbicides or hire additional labour
52 during peak periods. In the Zambezi Valley cotton farmers receive most of their farm inputs –
53 seeds, fertilisers and pesticides – on credit from cotton companies that recover their
54 investments in cotton. There is relatively little direct purchase of agricultural inputs. The
55 wealthiest farmers (Type 4) spend on average only 4% of their total cash income directly on
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3 agricultural inputs, while for other farmer types this is 1% or less. Problems of availability,
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5 high prices and a hyper-inflationary economic environment have reduced the possibility of
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7 direct purchases of inputs in recent years. Zambezi Valley farmers who do access mineral
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9 fertilisers on credit tend to use small quantities on their cotton, as credit recovery rates are
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11 high¹⁸. Therefore, fertile land is generally secured by investing labour in clearing an
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13 additional piece of land before the rains start (that is before labour peaks), rather than by
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15 purchasing fertiliser to maintain the fertility of already cultivated lands. This investment
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17 strategy was revealed by the Dande Game: when offered hypothetical increases in assets all
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19 farmers expanded the area of land they cultivated, instead of concentrating resources on the
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21 land already cultivated.
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27 Farmers' peak expenditure, at planting and first weeding between November and January,
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29 reflects the investment pattern of labour hiring¹⁹. Especially farmers growing cotton on large
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31 land areas (Type 3+4) hire additional labour for weeding (Figure 4). However, during labour
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33 peaks labour availability is reduced and labour costs increase (White et al., 2005). By
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35 contrast, labour is cheap before the rainy season, as poorer hand-hoe farmers (Type 1 and 2)
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37 are keen to earn cash to purchase food. This cheap labour allows wealthier farmers to clear
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39 large tracts of fertile land for agriculture. Thus, agricultural extensification is not only driven
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41 by the high cost of fertilisers compared with the farm gate prices of agricultural commodities,
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43 making its use unprofitable, but also by the availability of cheap labour outside peak periods.
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49 Agricultural intensification strategies that require hiring labour, particularly – as in the
50
51 case of CA – during peak periods when labour is scarce and expensive, require substantially
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53 more cash investment. Strategies that increase cash requirements for inputs and/or for hiring
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55 labour are unlikely to be adopted when the profitability of small-scale farming remains stable
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57 or declines, as has recently been the case for cotton profitability in Zimbabwe.
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Figure 4

Agricultural intensification vs. mitigating risk

Both strategies for farmers to increase production – agricultural intensification and agricultural extensification – require more labour and/or cash inputs. But clearing new fertile lands during off-peak periods does not only require less cash than investing in fertilisers, extending one's field has other advantages as well. Farmers generally prefer to spread their labour and cash inputs to reduce the risk of crop failure.

First, in the Zambezi Valley, having a number of fields, with different soils, planted with different crops, and managed differently, is a strategy to mitigate risks of drought, pest attacks and destruction by wildlife. For instance, farmers indicated that soils richer in clay (“*mutapo*”) are best suited for cotton. However, when exploring different cropping patterns through the Dande Game – ‘what would you grow if you had access to all soil types?’ – farmers indicated that in years of drought, cotton performs better on sandy loam (“*bandate*”) ²⁰. Thus they explained their preference to spread cotton cultivation over fields with contrasting soil types given the unpredictable rainfall, rather than concentrating on one field.

Second, agricultural extensification can also serve to mitigate the effects of drought on cereal production. Farmers indicated that in dry years, those who planted a large field always harvested something: as weeds do not develop as strongly in dry years, farmers can manage large fields with less labour than during higher rainfall years. Half of the interviewed farmers indicated that during a drought year, two acres of maize weeded once would yield more than one acre of maize weeded twice.

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3 *Crop demands, markets, livelihoods and in/extensification pathways*
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9 As already alluded to, market prices influence farm development pathways. For instance, land
10 scarcity and higher producer prices near urban markets may drive agricultural intensification
11 (Bamire and Manyong, 2003; Erenstein, 2006). Equally, relative land abundance and high
12 input prices in remote areas such as the Zambezi Valley, may predispose farmers to
13 extensification. Woodhouse (2002) noted that these socio-economic factors may be even more
14 important than agro-ecological conditions in explaining population growth and the orientation
15 of farm production towards intensification or extensification.
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26 The cash and labour demands of specific crops as well as their different uses also shape
27 such farm development pathways. Different crops have specific meanings for people. A
28 comparison of cotton and cereal production in the Zambezi Valley can illuminate this. Poor
29 market prices for cereals mean that these crops are primarily grown for food although surplus
30 production may be sold. Being independent from the market for one's food appears to be a
31 strong social force. Even well-endowed farming households specialised in cotton production
32 do not cease to produce cereals altogether.
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42 Second, different crops have different labour demands. During the 'Dande Game', when
43 asked to compare the cropped area of a farming household only growing cotton with the
44 cropped area the same household could manage when only growing cereals, farmers
45 highlighted the extra labour demand of cotton production for weeding and pesticide
46 application. They estimated that a household could manage 25-60% less land area under
47 cotton than under cereals. Accordingly, the farmers saw larger farming households – more
48 helping hands – as more suitable for cotton cultivation, while farms with more draught
49 animals and ploughs were considered best for cereal farming. Hence, the relative market
50 prices for cereals and cotton may drive farm development along an intensification or an
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3 extensification pathway. In the Zambezi Valley extensification is probable, as the profitability
4 of labour-demanding cotton has followed a declining trend in the past decade²¹, whilst cereal
5 marketing in Zimbabwe was liberalised in 2009.
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10 11 12 13 **6. Farmer practice and Conservation Agriculture: an unlikely marriage** 14

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17 The above exploration of farm practices reveals how limited cash, labour peaks, low output
18 and high input prices, and risk aversion, predispose smallholder farmers in southern Africa to
19 agricultural extensification. The availability of – relatively fertile – land enables such an
20 expansive farm development pathway in the Zambezi valley, but such a development is
21 perhaps unlikely in areas characterised by high land pressure and poor soils. Nevertheless, the
22 Zambezi Valley case illuminates why the technologies for agricultural intensification as
23 promoted in CA are problematic in many smallholder farming contexts.
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37 *Ploughing: the hallmark of a good farmer*
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42 Although diverse in terms of their farming practices and their endowment, interviewed
43 farmers' responses to the questions: 'What makes a good farmer? What does (s)he have or do
44 differently than others?' were strikingly similar: having animal draught power, a plough and a
45 cultivator, were seen as the main attributes of a good farmer (Table 2). As for Alvord in the
46 1920s, the plough remains the hallmark of good farming.
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3 As already shown above, Zambezi Valley farmers value the plough foremost for weed
4 control (67%). Secondly, in the hot and dry climate of the Zambezi Valley where yields are
5 foremost limited by water availability, ploughing is perceived as a means to increase moisture
6 retention (52%) and water infiltration (45%) (Table 3). Finally, smallholders value the plough
7 for the rapid land preparation it permits (24%). In low rainfall areas, the optimum planting
8 window is narrow and the plough enables large areas of land to be cultivated quickly
9 (Nyamudeza, 1999).

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20 Farmer's appreciation of plough use as a way to maximise the utilization of rainwater,
21 diametrically contradicts the view of CA protagonists, who argue that plough use should be
22 minimised to increase water use efficiency (Gowing and Palmer, 2008; Rockström et al.,
23 2008). Agronomists agree that on (clay-poor) loamy soils, such as those found in the Zambezi
24 Valley, soil crusting occurs, leading to run-off and poor water infiltration. The crust can be
25 broken by ploughing or, alternatively, its formation can be avoided by mulching as is
26 proposed with CA (Awadhwal and Thierstein, 1985). Why then do farmers not mulch?
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Table 3

Mulching vs. burning crop residues

51 Removing crop residues (for cattle feed) or burning them is a widespread practice among
52 smallholder farmers in the Zambezi Valley – three quarters of the farmers interviewed did so.
53 Hand-hoe farmers do so because retained crop residues – mulch – increase the labour burden
54 during planting and weeding in the beginning of the season (Table 4). It may increase labour
55 costs, as a labour hiring hand-hoe farmer explained:

“Casual workers charge you more to open planting stations in fields where you did not burn.”²²

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3 Such considerations are not relevant to those who plough, since ploughing incorporates
4 most of the residues. However residue burning may also be practiced to reduce pests and
5 weeds or to release nutrients for the crop to be planted (Table 4). During group interviews,
6 other reasons included: facilitating mice hunting, avoiding trampling of one's field by free
7 grazing cattle, and not attracting dangerous wildlife like elephants and buffaloes that feed on
8 crop residues. While some reasons are specific to the Zambezi Valley, to abandon burning
9 involves an additional labour input; for planting and weeding, as well as for constructing fire
10 breaks as fires often spread from neighbouring fields²³.
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Table 4

The impossibility of frequent crop rotation

Both the Alvord and CA packages for agricultural intensification emphasise the importance of crop rotation, albeit for different reasons. For Alvord, making best use of available soil nutrients was a prime concern, and he promoted a four-year rotation with two consecutive years of maize, followed by a legume crop and a small grain crop. Consequently, half of the farm should be occupied by maize and the other half by legume and small grain crops. In CA, annual crop rotation is required as pests and diseases may be carried over to the following crop in the mulch. This means that the farm should be occupied by at least two crops on equal areas. Both types of crop rotations are highly problematic for smallholders. Firstly, not all farmers grow a wide variety of crops, or cultivate similar land areas to different crops.²⁴

Secondly, as already mentioned above many farmers have access to different types of soils that differ in their suitability for particular crops. Farmers' preferred combinations of crops and soil types were brought out by the 'Dande Game': 1) maize on "bandate" soils

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3 close to the rivers, 2) sorghum and cowpea on “bandate” soils, but further away from the
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5 rivers; 3) groundnuts on lighter “shapa” soils, and; 4) cotton on “mutapo” (the heavier soils).
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7 Although limited access to specific soil types, food security and risk spreading considerations
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9 complicate such ideal-typical combinations in practice, these preferences make crop rotation
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11 impractical.
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18 *‘Intercropping with legumes is for poor farmers’*
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22 Intercropping with cover crops, especially legumes, is often promoted in CA. However, in the
23
24 Zambezi Valley only 20% of the interviewed farmers were practicing legume intercropping –
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26 mainly groundnuts and cowpea with a cereal. The main reason given for not intercropping
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28 was crop competition, resulting in a decline in yield of the legume crop. Farmers may also
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30 associate legume intercropping with poverty:
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35 “A good farmer is not supposed to practise intercropping; intercropping is mainly done by old people who
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37 are trying to make the most out of a small piece of land.”²⁵
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41 Thus, although the benefits of legume intercropping are well documented in the scientific
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43 literature (for example Craufurd, 2000), farmers in the Zambezi Valley appear committed to
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45 sole cropping as promoted in the Alvord model (Table 1a).
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50 **7. Conclusions: Failing to yield, or failing to innovate?**

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56 Whereas interventions in African agriculture have been aimed at agricultural intensification,
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58 the analyses presented in this article show how the socio-economic constraints faced by many
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60 smallholder farmers – that is limited cash, labour peaks, low output and high input prices, and

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3 high risks – predispose them towards extensification. Technical packages which may
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5 exacerbate such constraints are ill-suited to the circumstances of smallholder farmers. In the
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7 Zambezi Valley, where labour availability for weeding is a major limiting factor, the
8
9 increased weed pressure in CA is a major – but probably not the only – reason preventing
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11 farmers from embracing it. Without more attractive prices for farm produce, or other sources
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13 of income, farmers will not be able to hire additional labour, or to purchase the labour-saving
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15 herbicides required to overcome the increased weed problems that may result from CA
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17 adoption.
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22 Agricultural technologies do not, however, have strict intensifying or extensifying
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24 properties: often they have both. It is the interaction between the technology and the agro-
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26 ecological and socio-economic environments which directs farming on an intensification or
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28 extensification pathway. The example of the plough in Alvord's time is illustrative: although
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30 its use was promoted to intensify land use, its adoption often meant a 'diversion' towards
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32 extensification. Similarly, depending on the circumstances in which it is introduced, CA may
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34 not contribute much to agricultural intensification, but may result in agricultural expansion
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36 and extensification. For instance, the widespread adoption of CA and herbicides in the
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38 Brazilian Cerrados went hand in hand with a massive expansion of agricultural land (Landers,
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40 2001; Klink and Macado, 2005).
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46 As has been highlighted above, smallholder farming in the Zambezi Valley cannot be
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48 taken as representative for the southern African region as a whole, as its hot climate and
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50 relatively fertile soils render weeding rather than planting the major labour peak in
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52 production. Land abundance – enabling agricultural extensification – is, however, less
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54 specific to the Zambezi Valley than may be assumed. In areas with denser populations than
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56 the Zambezi Valley (17 pers. km⁻² in 2002), such as Malawi's southern province (>200 pers.
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58 km⁻², Benson et al. 2002), acute land shortage may indeed preclude agricultural
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extensification. Yet, in most parts of southern Africa population densities are relatively low: 18 pers. km⁻² in Zambia, 29 in Mozambique and 32 in Zimbabwe²⁶. Agricultural extensification is not merely a predisposition of smallholder farmers, but often a realistic possibility for farm development as is apparent from high deforestation rates in the region (for example 1% per annum in Zambia, 1.7% per annum in Zimbabwe²⁷). Farm expansion into grazing lands, and the hiring of unused land are also common options (Chimhowu and Woodhouse, 2008).

We may therefore conclude that despite sustained efforts to intensify smallholder agriculture, farmers in the region have been 'failing to yield'. The repeated failure of intervention models to learn from the rationale of smallholder production systems goes a long way in explaining their adoption failure. From Alvord to CA, local practices have been disregarded by interventionists, and the persistent conviction that the problem of low productivity and land degradation in African agriculture is purely technical has led interventions to be limited to attempts to change farmer 'mindsets', through demonstration and trainings. This approach has changed little in almost a century of agricultural research and extension. More worrying than smallholders failure to increase yields, seems to have been the failure of researchers, policy makers, donors and development agencies to innovate.

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Notes

- ¹ Quote from: E.D. Alvord (not dated) *The Gospel of the Plow or A Guided Destiny (unpublished autobiography of the Agriculturalist for Natives)*, National Archives of Zimbabwe (NAZ).
- ² The Zimbabwe Conservation Agriculture Taskforce is a collaborative effort of the FAO, ICRISAT, CIMMYT, the EU, DfID and a number of (faith-based) international donor organizations.
- ³ wwwFOUNDATIONSFORFARMING.org (visited 23 November 2010).
- ⁴ The FAO defines Conservation Agriculture as: ‘...resource-saving agricultural crop production that strives to achieve acceptable profits together with high and sustained production levels while concurrently conserving the environment. www.fao.org/ag/ca/1a.html (visited 23 November 2010).
- ⁵ During the 2009-2010 season, 180,000 Zambian smallholders received support to practice conservation agriculture (www.conservationsagriculture.org, visited 23 November 2010), while in Zimbabwe a consortium of donors supported more than 110,000 farmers to do so (www.prpzim.info, visited 23 November 2010).
- ⁶ Speech for the official opening of the Parliament of Zimbabwe in July 2010 (The Herald, 20 July 2010).
- ⁷ Conservation Farming packages as promoted by ICRISAT perhaps constitute an exception as they specifically target food insecure farmers with no cattle and plough, acknowledging these farmers’ need to reduce labour peaks (see Twomlow et al., 2008b).
- ⁸ Agronomists generally use “sole cropping” to refer to the practice of planting one crop in one field.. In Alvord’s days this practice was known as mono-cropping, which is now often taken to mean one crop in a field continually year after year.
- ⁹ The strategic use of soil erosion figures to argue for urgent action is exemplified by Whitlow (1987), who mentioned soil losses of 40 tons ha⁻¹ year⁻¹ in Zimbabwean Communal Areas. Disregarding the accuracy of the figure, this apparently massive figure translates to top soil loss of 2.7 mm per year (assuming a bulk density of top soil of 1.5 g cm⁻³). Such strategic use of soil erosion figures re-surfaces in contemporary CA promotion messages (Field Observations, Foundations for Farming Open day, River of Life Church, Harare, 1 February 2011).
- ¹⁰ Alvord recommended 10-15 tons kraal manure per acre (37 tons per ha) every four years (Grant, 1976: 252). Manure use was also limited as it increased weed infestation (Bolding, 2003: 52), and its effectiveness depended on soil type and rainfall conditions (McGregor, 1995)
- ¹¹ Colony of Southern Rhodesia Statistical Bureau (1932) *Official Yearbook of the Colony of Southern Rhodesia no.3*, Salisbury, Government Printer. p.670. In this yearbook, average grain yield was estimated to be 700 kg ha⁻¹ in 1902, and decreased to an estimated 500 kg ha⁻¹ in 1930. The number of ploughs in the Native Reserves increased exponentially, ‘and by 1940 nearly every family owned one’ (Scoones et al., 1996; Palmer, 1977). In that year there were about hundred agricultural demonstrators based in the Native Reserves (Davis, 1992: 53).
- ¹² http://wwwFOUNDATIONSFORFARMING.org/Groups/104832/Foundations_for_Farming/Resources/Resources.aspx (Visited 23 November 2010)
- ¹³ http://www.worldagroforestry.org/ea/?page_id=6 (Visited 23 November 2010)
- ¹⁴ An example is the promotional video on www.fao.org/ag/ca (visited 23 November 2010).
- ¹⁵ Conventional’ farming without fertilisers is often compared with CA with – donor supported – fertiliser (see CBDC, 2009). Thus, in these comparisons, the effect of CA *per se* is confounded with the effect of fertilisers. Moreover, CA adoption may be driven by NGO supported inputs more than by the merits of CA itself (Mazvimavi and Dimes (2009). Note the similarity with the valued labour input provided by Alvord’s demonstrators.
- ¹⁶ Faith-based donor organizations such as Catholic Relief Services and Care International, invest substantially in CA promotion, while FAO and other donors fund CA trainings at the River of Life church.
- ¹⁷ The distinction between “hand-hoe” and “ploughing” is based on the mode of land preparation for the main dryland crops. Type 1 and 2 farmers never use animal draught power, while Type 3 and 4 farmers may occasionally use hand-hoes in riverbank fields or in gardens.
- ¹⁸ Data from the EU-PARSEL project show that during the 2008-2009 season, farmers were using, on average, only 12 kg N ha⁻¹, 34 kg P ha⁻¹ and 6 kg ha⁻¹ on their cotton fields.
- ¹⁹ The expenditure peak partly corresponds with the beginning of the school year, when school fees, uniforms and stationary need to be purchased.

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- ²⁰ Sandy clay loam has a high water retention capacity, but also a high permanent wilting point. These soils require substantial rainfall before water becomes available for the crop. Sandy loam has less capacity to retain moisture and a lower permanent wilting point.
- ²¹ A farmer explained '250 kg could buy one head of cattle in the 1990s; nowadays, twice this amount is required' (Interview with Mr R. Matongora, Madzeverete, 9 November 2009)
- ²² Interview with Courage Nhamoyemari (2 February 2010).
- ²³ Fires may spread from neighbouring farms or natural vegetation, that are annually burnt for a number of reasons, for example to facilitate hunting of antelopes.
- ²⁴ For instance, in the Zambezi Valley in 2006, hand-hoe farmers were growing an average of 1.1 ha of cereals and an average of 0.7 ha of cotton ($n = 78$), whilst ploughing farmers were growing an average of 1.3 ha of cereals and an average of 2.6 ha of cotton ($n = 98$).
- ²⁵ Interview with Rambros Matongora (9 November 2009)
- ²⁶ Population figures of 2008, United Nations Population Division (<http://esa.un.org/UNPP/>, visited 23 November 2010)
- ²⁷ Deforestation rates for the period 2000-2005, data from the Global Forest Resource Assessment of 2005 (http://foris.fao.org/static/data/fra2005/global_tables/FRA_2005_Global_Tables_EN.xls, visited 23 November 2010)

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Figure 1 – Three pathways to increase production: Extensification, Green Revolution (increased use of external inputs) and Ecological intensification (improved resource-use efficiency). Downward arrows represent water and nutrient losses. Sizes of the various arrows are proportional to the corresponding fluxes. Impact of the three pathways on yield (i.e. harvest per surface area) and quantity of input used per surface area is described by ' \cong ', meaning the value remains roughly constant; '>', meaning the value increases; and '>>', meaning the value increases greatly.

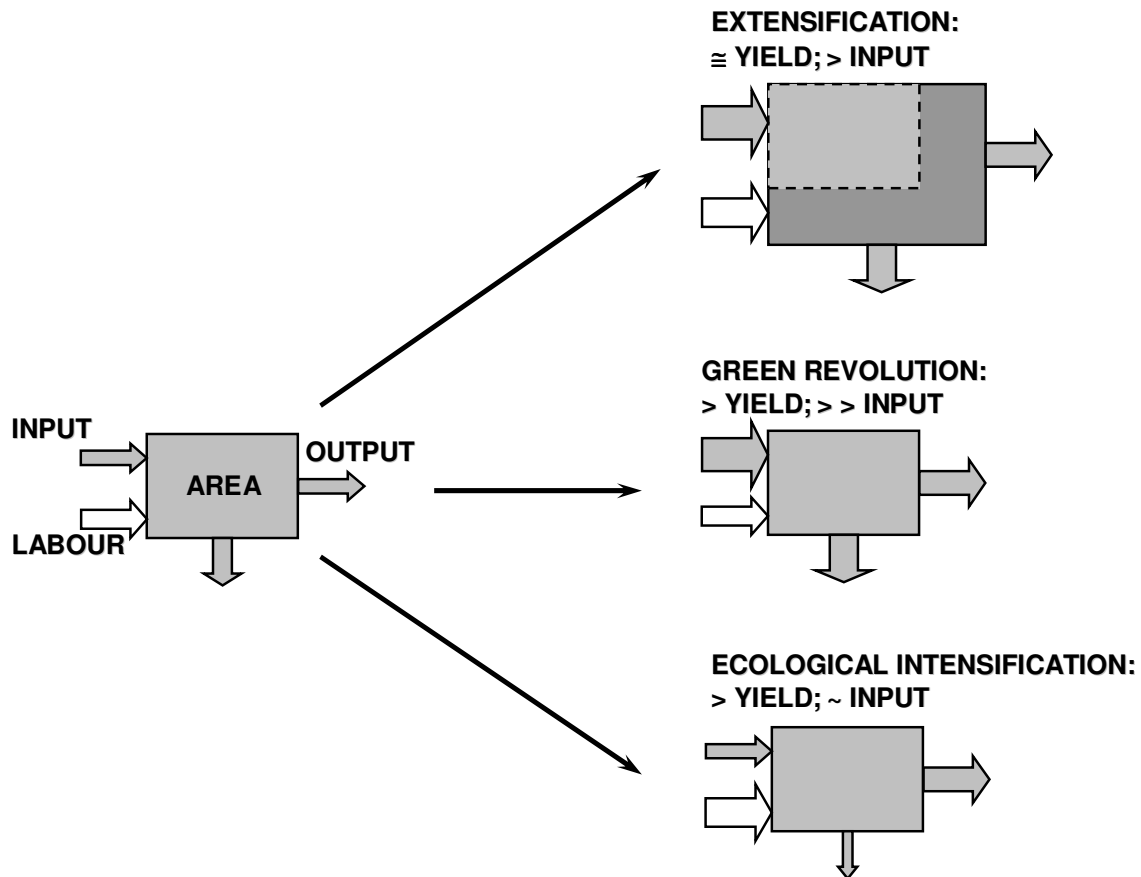
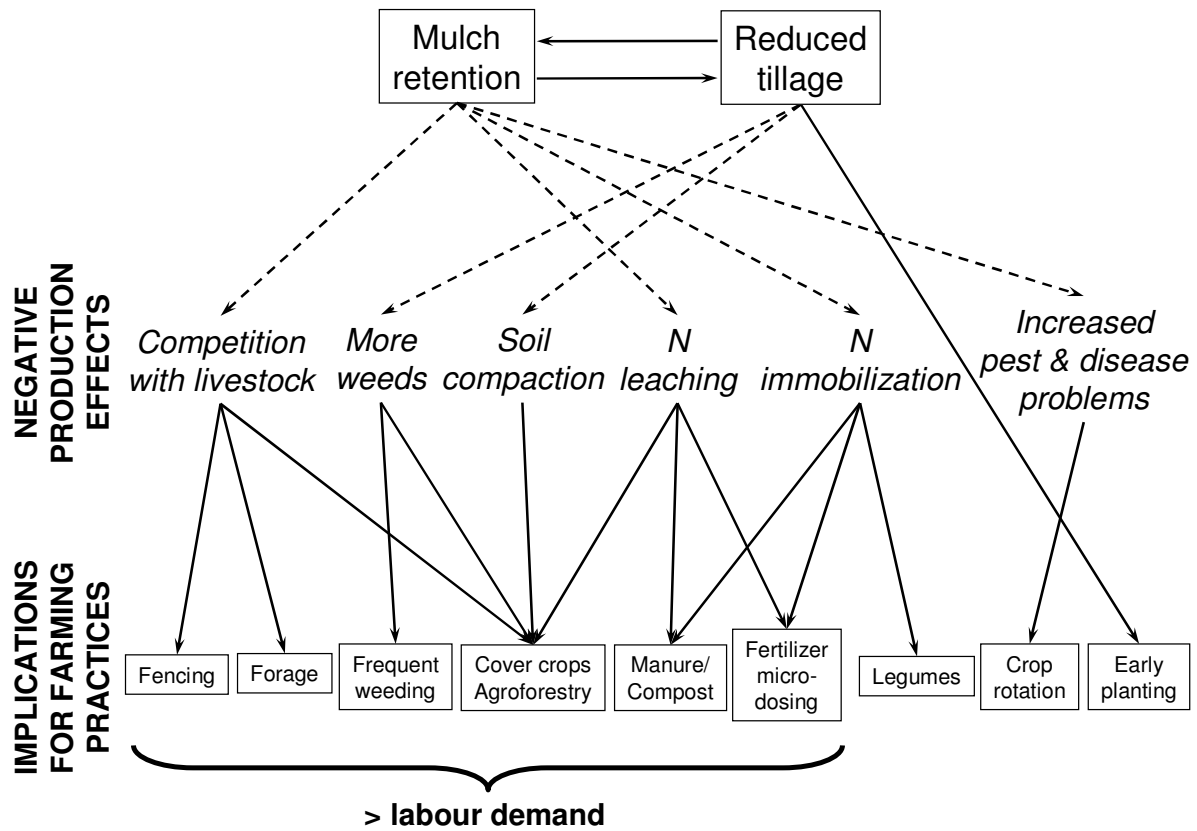
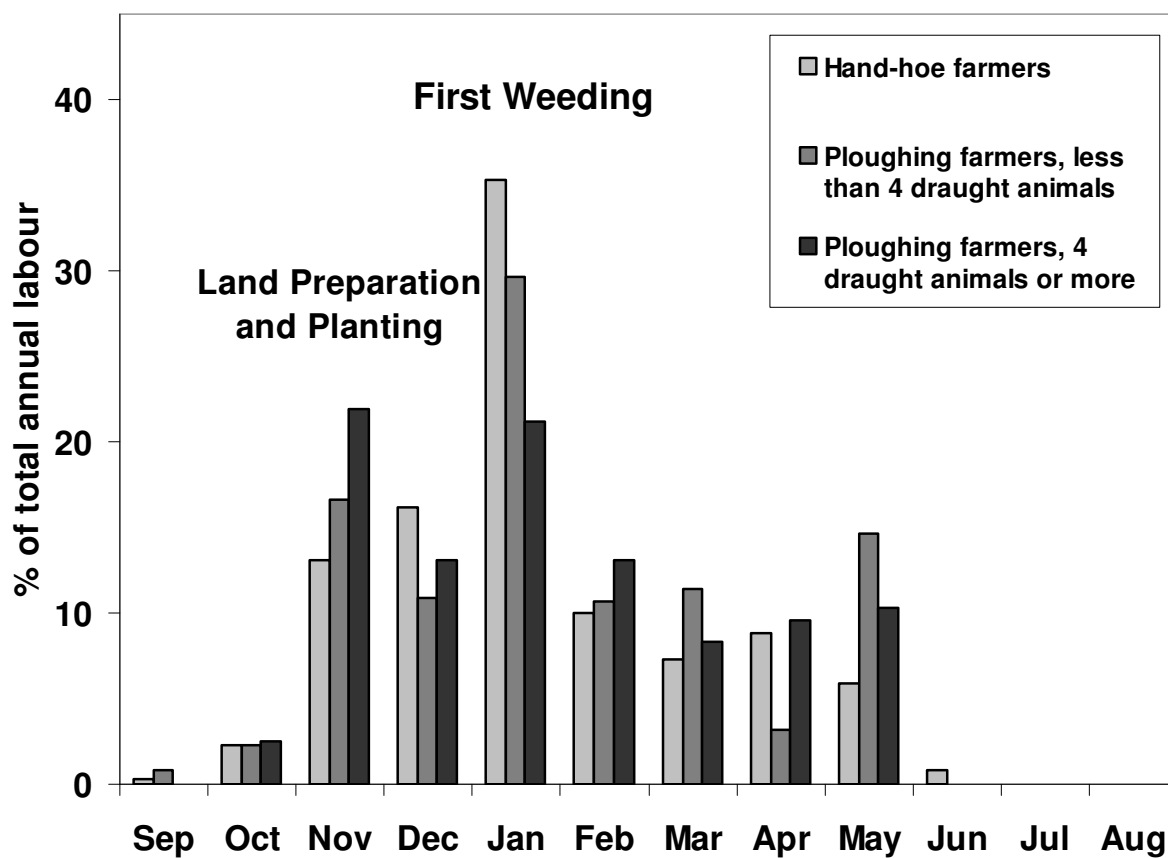


Figure 2 – Two main principles of CA and their consequences: possible negative effects on production and implications for farming practices.



View Only

Figure 3 – Mean monthly labour allocation for three types of farmers during the 2007-08 season in Dande Communal Land, Zimbabwe (*n* = 38).



View Only

Figure 4 – Mean monthly cash allocation for three types of farmers during the season 2007-08 in Dande Communal Land, Zimbabwe ($n = 38$). Cash expenditure during the period November-January represent labour hiring and, to a lesser extent, expenses related to schooling. Cash expenditures in the period May-July represent the purchase of clothes, productive assets such as livestock and other household needs using cotton income.

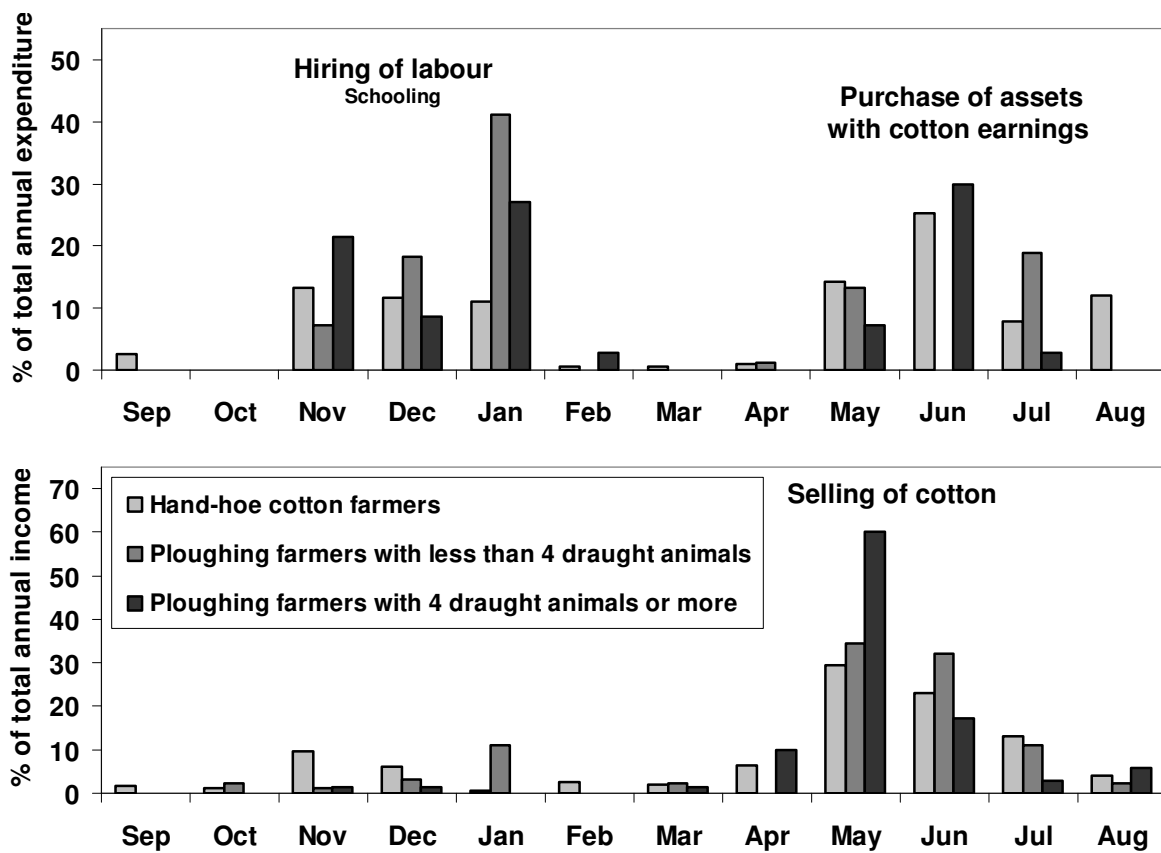


Table 1 – Components of a) the Alford model and b) Conservation Agriculture and their impact on yield and labour needs (+/0/- indicate positive, neutral and negative impacts, respectively; arrows indicate implications)

a)

Components	Yield	Labour needs
Ploughing	+ ⁽¹⁾	-
Manuring	+	+ ⁽²⁾
Crop rotation (with legumes)	+ ⁽⁴⁾	0
Sole-cropping/tree removal	+ ⁽⁵⁾	- ⁽⁶⁾
Planting in lines/cultivating ⁽⁷⁾	+ ⁽⁸⁾	- ⁽⁸⁾

⁽¹⁾ reduces weed population, increases mineralization of organic matter, increases water infiltration

⁽²⁾ extra-labour required for manure collection, composting and transport to the field

⁽³⁾ the dashed arrow indicates that ploughing implies tree removal, but not necessarily sole-cropping

⁽⁴⁾ controls pest, increases nitrogen supply in the case of legumes

⁽⁵⁾ reduces competition between crop species and between crop and trees

⁽⁶⁾ efficient operations (one crop per field means uniform fertilizer requirements, harvesting dates, etc.)

⁽⁷⁾ cultivating indicates weeding using an animal-drawn cultivator or plough between the crop rows

⁽⁸⁾ makes efficient weeding possible

b)

Components	Yield	Labour needs	
		Land Prep and Planting	Weeding
Minimum tillage	+/- ⁽¹⁾	+	- ⁽²⁾
Mulch retention	+/- ⁽³⁾	- ⁽⁴⁾	+/- ⁽⁵⁾
Crop rotation (with legumes)	+ ⁽⁶⁾	0	0
Cover crops	+	-	+/-

⁽¹⁾ preserves soil organic matter and soil structure, but may also lead to soil compaction and crusting

⁽²⁾ generally increases the number and intensity of weeding operations

⁽³⁾ may reduce soil crusting, may increase water infiltration and reduce evaporation, but may also increase waterlogging, leaching and immobilization of nitrogen

⁽⁴⁾ generally makes planting more difficult

⁽⁵⁾ may control weeds by shading but mulch may contain seeds of weeds and mulch makes weeding by hand or cultivator more difficult

⁽⁶⁾ controls pests, increases nitrogen supply in the case of legumes

Table 2 – ‘What makes a good farmer (*murimi akanaka*)? What does (s)he have or do differently than others?’ (n=36)

What makes a good farmer?	Number of respondents	Proportion of respondents
Having animal draught power, plough(s) and cultivator(s)	35	97%
Producing surpluses	17	47%
Having seeds (quantity and quality)	13	36%
Having manpower (family and/or hired labour)	12	33%
Having a large field	9	25%
Practicing proper weeding	5	14%
Using chemicals (fertilizers, pesticides, etc)	5	14%

Table 3 – “What are the benefits of ploughing?” (*n*=34)

Reasons for ploughing	Number of respondents	Proportion of respondents
Weed control	22	67%
Increased moisture retention	17	52%
Improved water infiltration	15	45%
Fast and easy plant growth due to loosened soil	17	52%
Fast land preparation / big land	8	24%

Table 4 – “Why do you burn residues?” (n=26)

Reasons for burning	Number of respondents	Proportion of respondents
Easier land preparation and weeding	18	72%
Reduction in termite and millipede populations	6	24%
Weed control	5	20%
Increased fertility	4	16%